General

Guideline Title

2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction. A report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines.

Bibliographic Source(s)

O'Gara PT, Kushner FG, Ascheim DD, Casey DE Jr, Chung MK, de Lemos JA, Ettinger SM, Fang JC, Fesmire FM, Franklin BA, Granger CB, Krumholz HM, Linderbaum JA, Morrow DA, Newby LK, Ornato JP, Ou N, Radford MJ, Tamis-Holland JE, Tommaso CL, Tracy CM, Woo YJ, Zhao DX. 2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol. 2013 Jan 29;61(4):e78-140. [656 references] PubMed

Guideline Status

This is the current release of the guideline.

This guideline updates previous versions: Antman EM, Anbe DT, Armstrong PW, Bates ER, Green LA, Hand M, Hochman JS, Krumholz HM, Kushner FG, Lamas GA, Mullany CJ, Ornato JP, Pearle DL, Sloan MA, Smith SC Jr. ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction. A report of the Am Coll of Cardiol/Am Heart Assoc Task Force on Practice Guidelines (Committee to revise the 1999 guidelines). Bethesda (MD): American College of Cardiology (ACC), American Heart Association (AHA); 2004. 211 p.

Canadian Cardiovascular Society, American Academy of Family Physicians, American College of Cardiology, American Heart Association, Antman EM, Hand M, Armstrong PW, Bates ER, Green LA, Halasyamani LK, Hochman JS, Krumholz HM, Lamas GA, Mullany CJ, Pearle DL, Sloan MA, Smith SC Jr, Anbe DT, Kushner FG, Ornato JP, Pearle DL, Sloan MA, Jacobs AK, Adams CD, Anderson JL, Buller CE, Creager MA, Ettinger SM, Halperin JL, Hunt SA, Lytle BW, Nishimura R, Page RL, Riegel B, Tarkington LG, Yancy CW. 2007 focused update of the ACC/AHA 2004 guidelines for the management of patients with ST-elevation myocardial infarction: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol 2008 Jan 15;51(2):210-47.

Recommendations

Major Recommendations

Definitions for the level of the evidence (A-C) and classes of recommendations (I-III) are provided at the end of the "Major Recommendations" field.

Onset of Myocardial Infarction

Community Preparedness and System Goals for Reperfusion Therapy

Regional Systems of ST-Elevation Myocardial Infarction (STEMI) Care, Reperfusion Therapy, and Time-to-Treatment Goals

See Figure 2, "Reperfusion therapy for patients with STEMI," in original guideline document.

<u>Class I</u>

1. All communities should create and maintain a regional system of STEMI care that includes assessment and continuous quality improvement of emergency medical services (EMS) and hospital-based activities. Performance can be facilitated by participating in programs such as Mission: Lifeline and the Door-to Balloon (D2B) Alliance (Le May et al., 2008; Aguirre et al., 2008; Henry et al., 2007; Jollis et al., 2007). (Level of Evidence: B)
2. Performance of a 12-lead electrocardiogram (ECG) by EMS personnel at the site of first medical contact (FMC) is recommended in patients with symptoms consistent with STEMI (Sørensen et al., 2011; Le May et al., 2008; Rokos et al., 2009; Dieker et al., 2010; Diercks et al., 2009). (Level of Evidence: B)
3. Reperfusion therapy should be administered to all eligible patients with STEMI with symptom onset within the prior 12 hours (Fibrinolytic Therapy Trialists' [FTT] Collaborative Group, 1994; Keeley, Boura, & Grines, 2003). (Level of Evidence: A)
4. Primary percutaneous coronary intervention (PCI) is the recommended method of reperfusion when it can be performed in a timely fashion by experienced operators (Keeley, Boura, & Grines, 2003; Andersen et al., "Danish multicenter," 2003; Dalby et al., 2003). (Level of Evidence: A)
5. EMS transport directly to a PCI-capable hospital for primary PCI is the recommended triage strategy for patients with STEMI, with an ideal FMC-to-device time system goal of 90 minutes or less* (Sørensen et al., 2011; Le May et al., 2008; Rokos et al., 2009). (Level of Evidence: B)
6. Immediate transfer to a PCI-capable hospital for primary PCI is the recommended triage strategy for patients with STEMI who initially arrive at or are transported to a non–PCI-capable hospital, with an FMC-to-device time system goal of 120 minutes or less* (Andersen et al., "Danish multicenter," 2003; Dalby et al., 2003; Andersen et al., "A comparison," 2003; Nielsen et al., 2011). (Level of Evidence: B)
7. In the absence of contraindications, fibrinolytic therapy should be administered to patients with STEMI at non–PCI-capable hospitals when the anticipated FMC-to-device time at a PCI-capable hospital exceeds 120 minutes because of unavoidable delays (FTT Collaborative Group, 1994; Nallamothu & Bates, 2003; Pinto et al., 2006). (Level of Evidence: B)
8. When fibrinolytic therapy is indicated or chosen as the primary reperfusion strategy, it should be administered within 30 minutes of hospital arrival* (Boersma et al., 1996; Chareonthaitawee et al., 2000; McNamara et al., 2007; Milavetz et al., 1998; Newby et al., 1996). (Level of Evidence: B)

*The proposed time windows are system goals. For any individual patient, every effort should be made to provide reperfusion therapy as rapidly as possible.

<u>Class IIa</u>

1. Reperfusion therapy is reasonable for patients with STEMI and symptom onset within the prior 12 to 24 hours who have clinical and/or ECG evidence of ongoing ischemia. Primary PCI is the preferred strategy in this population (FTT Collaborative Group, 1994; Schömig et al., 2005; Gierlotka et al., 2011). (Level of Evidence: B)

The Relationship Between Sudden Cardiac Death and STEMI

Evaluation and Management of Patients with STEMI and Out-of-Hospital Cardiac Arrest

<u>Class I</u>

1. Therapeutic hypothermia should be started as soon as possible in comatose patients with STEMI and out-of-hospital cardiac arrest caused by ventricular fibrillation (VF) or pulseless ventricular tachycardia (VT), including patients who undergo primary PCI (Peberdy et al., 2010; Bernard, 2002; Hypothermia after Cardiac Arrest Study Group, 2002). (Level of Evidence: B)
2. Immediate angiography and PCI when indicated should be performed in resuscitated out-of-hospital cardiac arrest patients whose initial ECG shows STEMI (Nichol et al., 2010; Bendz et al., 2004; Borger van der Burg et al., 2003; Bulut et al., 2000; Garot et al., 2007; Gorjup et al., 2007; Hosmane et al., 2009; Kahn et al., 1995; Keelan et al., 2003; Kern & Rahman, 2010; Marcusohn et al., 2007; Pleskot et al., 2008; Quintero-Moran et al., 2006; Richling et al., 2007; Spaulding et al., 1997; Werling et al., 2007). (Level of Evidence: B)

<u>Reperfusion at a PCI-Capable Hospital</u>

Primary PCI

Primary PCI in STEMI

See Table 2 in the original guideline document for a summary of recommendations from this section.

Class I

1. Primary PCI should be performed in patients with STEMI and ischemic symptoms of less than 12 hours' duration (Keeley, Boura, & Grines, 2003; Zijlstra et al., 1999; "A clinical trial comparing primary coronary angioplasty," 1997). (Level of Evidence: A)
2. Primary PCI should be performed in patients with STEMI and ischemic symptoms of less than 12 hours' duration who have contraindications to fibrinolytic therapy, irrespective of the time delay from FMC (Grzybowski et al., 2003; Zahn et al., 1999). (Level of Evidence: B)
3. Primary PCI should be performed in patients with STEMI and cardiogenic shock or acute severe heart failure (HF), irrespective of time delay from myocardial infarction (MI) onset (Hochman et al., 1999; Hochman et al., "Coronary intervention," 2006; Thune et al., 2005; Wu et al., 2002). (Level of Evidence: B)

Class IIa

1. Primary PCI is reasonable in patients with STEMI if there is clinical and/or ECG evidence of ongoing ischemia between 12 and 24 hours after symptom onset (Schömig et al., 2005; Gierlotka et al., 2011). (Level of Evidence: B)

Class III: Harm

1. PCI should not be performed in a noninfarct artery at the time of primary PCI in patients with STEMI who are hemodynamically stable (Hannan et al., 2010; Toma et al., 2010; Vlaar et al., 2011). (Level of Evidence: B)

Aspiration Thrombectomy

Class IIa

1. Manual aspiration thrombectomy is reasonable for patients undergoing primary PCI (Vlaar et al., 2008; Stone et al., 2012; Bavry, Kumbhani, & Bhatt 2008; Sardella et al., 2009). (Level of Evidence: B)

Use of Stents in Primary PCI

Use of Stents in Patients with STEMI

Class I

1. Placement of a stent (bare-metal stent [BMS] or drug-eluting stent [DES]) is useful in primary PCI for patients with STEMI (Nordmann et al., 2004; Zhu et al., 2001). (Level of Evidence: A)
2. BMS† should be used in patients with high bleeding risk, inability to comply with 1 year of dual antiplatelet therapy (DAPT), or anticipated invasive or surgical procedures in the next year. (Level of Evidence: C)

†Balloon angioplasty without stent placement may be used in selected patients.

Class III: Harm

1. DES should not be used in primary PCI for patients with STEMI who are unable to tolerate or comply with a prolonged course of DAPT because of the increased risk of stent thrombosis with premature discontinuation of one or both agents (Spertus et al., 2006; KaÅ,uza et al., 2000; Grines et al., 2007; Park et al., 2006; Jeremias et al., 2004; Pfisterer et al., 2006; Nasser, Kapeliovich, & Markiewicz, 2005). (Level of Evidence: B)

Adjunctive Antithrombotic Therapy for Primary PCI

Antiplatelet Therapy to Support Primary PCI for STEMI

See Table 3 in the original guideline document for a summary of recommendations from this section.

Class I

1. Aspirin 162 to 325 mg should be given before primary PCI (Jolly et al., 2009; Barnathan et al., 1987; CURRENT-OASIS 7 Investigators, 2010). (Level of Evidence: B)
2. After PCI, aspirin should be continued indefinitely (Antithrombotic Trialists' Collaboration, 2002; Schömig et al., 1996; Smith et al., 2011). (Level of Evidence: A)

3. A loading dose of a P2Y$_{12}$receptor inhibitor should be given as early as possible or at time of primary PCI to patients with STEMI. Options include:
    a. Clopidogrel 600 mg (CURRENT-OASIS 7 Investigators et al., 2010; Patti et al., 2011; Mehta et al., 2010) (Level of Evidence: B)
    b. Prasugrel 60 mg (Wiviott et al., 2007) (Level of Evidence: B)
    c. Ticagrelor 180 mg (Steg et al., 2010) (Level of Evidence: B)
4. P2Y$_{12}$inhibitor therapy should be given for 1 year to patients with STEMI who receive a stent (BMS or DES) during primary PCI using the following maintenance doses:
    a. Clopidogrel 75 mg daily (Wiviott et al., 2007; Montalescot et al., 2009) (Level of Evidence: B)
    b. Prasugrel 10 mg daily (Montalescot et al., 2009) (Level of Evidence: B)
    c. Ticagrelor 90 mg twice a day‡ (Steg et al., 2010) (Level of Evidence: B)

‡The recommended maintenance dose of aspirin to be used with ticagrelor is 81 mg daily.

Class IIa

1. It is reasonable to use 81 mg of aspirin per day in preference to higher maintenance doses after primary PCI (CURRENT-OASIS 7 Investigators, 2010; Antithrombotic Trialists' Collaboration, 2002; Serebruany et al., 2005; Steinhubl et al., 2009). (Level of Evidence: B)
2. It is reasonable to begin treatment with an intravenous glycoprotein (GP) IIb/IIIa receptor antagonist such as abciximab (Brener et al., 1998; Stone et al., 2002; Montalescot et al., 2001) (Level of Evidence: A), high-bolus-dose tirofiban (ten Berg et al., 2010; Valgimigli et al., 2008) (Level of Evidence: B), or double-bolus eptifibatide (Akerblom et al., 2010) (Level of Evidence: B) at the time of primary PCI (with or without stenting or clopidogrel pretreatment) in selected patients with STEMI who are receiving unfractionated heparin (UFH).

Class IIb

1. It may be reasonable to administer intravenous GP IIb/IIIa receptor antagonist in the precatheterization laboratory setting (e.g., ambulance, emergency department) to patients with STEMI for whom primary PCI is intended (Ellis et al., 2004; ten Berg et al., 2010; Ellis et al., 2009; Montalescot et al., 2004; Maioli et al., 2007; Keeley, Boura, & Grines, 2006; Van't Hof et al., 2008; El Khoury et al., 2010; De Luca et al., 2011). (Level of Evidence: B)
2. It may be reasonable to administer intracoronary abciximab to patients with STEMI undergoing primary PCI (Stone et al., 2012; Mehilli et al., 2009; Bellandi et al., 2004; Romagnoli et al., 2005; Iversen, Galatius, & Jensen, 2008; Kakkar et al., 2004; Wöhrle et al., 2003; Bertrand et al., 2010). (Level of Evidence: B)
3. Continuation of a P2Y$_{12}$ inhibitor beyond 1 year may be considered in patients undergoing DES placement. (Level of Evidence: C)

Class III: Harm

1. Prasugrel should not be administered to patients with a history of prior stroke or transient ischemic attack (Wiviott et al., 2007). (Level of Evidence: B)

Anticoagulant Therapy to Support Primary PCI

Class I

1. For patients with STEMI undergoing primary PCI, the following supportive anticoagulant regimens are recommended:
    a. UFH, with additional boluses administered as needed to maintain therapeutic activated clotting time levels, taking into account whether a GP IIb/IIIa receptor antagonist has been administered (Level of Evidence: C)
    b. Bivalirudin with or without prior treatment with UFH (Stone et al., 2008) (Level of Evidence: B)

Class IIa

1. In patients with STEMI undergoing PCI who are at high risk of bleeding, it is reasonable to use bivalirudin monotherapy in preference to the combination of UFH and a GP IIb/IIIa receptor antagonist (Stone et al., 2008). (Level of Evidence: B)

Class III: Harm

1. Fondaparinux should not be used as the sole anticoagulant to support primary PCI because of the risk of catheter thrombosis (Yusuf et al., 2006). (Level of Evidence: B)

Reperfusion at a Non-PCI-Capable Hospital

Fibrinolytic Therapy When There Is an Anticipated Delay to Performing Primary PCI within 120 Minutes of FMC

See Table 4 in the original guideline document for a summary of recommendations from this section.

Class I

1. In the absence of contraindications, fibrinolytic therapy should be given to patients with STEMI and onset of ischemic symptoms within the previous 12 hours when it is anticipated that primary PCI cannot be performed within 120 minutes of FMC (FTT Collaborative Group, 1994; "Effect of intravenous APSAC," 1988; "Randomised trial of late thrombolysis," 1993; "Randomised trial of intravenous streptokinase," 1988; "Late Assessment of Thrombolytic Efficacy [LATE] study," 1993; Rossi & Bolognese, 1991; "A prospective trial of intravenous streptokinase," 1986). (Level of Evidence: A)

Class IIa

1. In the absence of contraindications and when PCI is not available, fibrinolytic therapy is reasonable for patients with STEMI if there is clinical and/or electrocardiographic evidence of ongoing ischemia within 12 to 24 hours of symptom onset and a large area of myocardium at risk or hemodynamic instability. (Level of Evidence: C)

Class III: Harm

1. Fibrinolytic therapy should not be administered to patients with ST depression except when a true posterior (inferobasal) MI is suspected or when associated with ST elevation in lead aVR (de Winter et al., 2008; Jong et al., 2006; FTT Collaborative Group, 1994; "Early effects of tissue-type plasminogen activator," 1993; Barrabés et al., 2003). (Level of Evidence: B)

Adjunctive Antithrombotic Therapy with Fibrinolysis

See Table 7 in the original guideline document for a summary of recommendations from this section.

Class I

1. Aspirin (162- to 325-mg loading dose) and clopidogrel (300-mg loading dose for patients ≤75 years of age, 75-mg dose for patients >75 years of age) should be administered to patients with STEMI who receive fibrinolytic therapy ("Randomised trial of intravenous streptokinase," 1988; Chen et al., "Addition of clopidogrel," 2005; Sabatine et al., 2005). (Level of Evidence: A)
2. Aspirin should be continued indefinitely ("Randomised trial of intravenous streptokinase," 1988; Chen et al., "Addition of clopidogrel," 2005; Sabatine et al., 2005) (Level of Evidence: A) and clopidogrel (75 mg daily) should be continued for at least 14 days (Chen et al., "Addition of clopidogrel," 2005; Sabatine et al., 2005) (Level of Evidence: A) and up to 1 year (Level of Evidence: C) in patients with STEMI who receive fibrinolytic therapy.

Class IIa

1. It is reasonable to use aspirin 81 mg per day in preference to higher maintenance doses after fibrinolytic therapy (Antithrombotic Trialists' Collaboration, 2002; Smith et al., 2011; Serebruany et al., 2005; Steinhubl et al., 2009). (Level of Evidence: B)

Adjunctive Anticoagulant Therapy with Fibrinolysis

Class I

1. Patients with STEMI undergoing reperfusion with fibrinolytic therapy should receive anticoagulant therapy for a minimum of 48 hours, and preferably for the duration of the index hospitalization, up to 8 days or until revascularization if performed ("An international randomized trial," 1993; Antman et al., 2006). (Level of Evidence: A) Recommended regimens include:
    a. UFH administered as a weight-adjusted intravenous bolus and infusion to obtain an activated partial thromboplastin time of 1.5 to 2.0 times control, for 48 hours or until revascularization (Level of Evidence: C)
    b. Enoxaparin administered according to age, weight, and creatinine clearance, given as an intravenous bolus, followed in 15 minutes by subcutaneous injection for the duration of the index hospitalization, up to 8 days or until revascularization (Antman et al., 2006; Assessment of the Safety and Efficacy of a New Thrombolytic Regimen [ASSENT]-3, 2001; Ross et al., 2001; Antman et al., 2002) (Level of Evidence: A)
    c. Fondaparinux administered with initial intravenous dose, followed in 24 hours by daily subcutaneous injections if the estimated creatinine clearance is greater than 30 mL/min, for the duration of the index hospitalization, up to 8 days or until revascularization (Yusuf et al., 2006) (Level of Evidence: B)

Transfer to a PCI-Capable Hospital after Fibrinolytic Therapy

Transfer of Patients with STEMI to a PCI-Capable Hospital for Coronary Angiography after Fibrinolytic Therapy

See Table 8 in the original guideline for a summary of recommendations from this section. See Online Data Supplement 4 for additional data on early catheterization and rescue PCI for fibrinolytic failure in the stent era; and Online Data Supplement 5 for additional data on early catheterization and PCI after fibrinolysis in the stent era (see the "Availability of Companion Documents" field).

Class I

1. Immediate transfer to a PCI-capable hospital for coronary angiography is recommended for suitable patients with STEMI who develop cardiogenic shock or acute severe HF, irrespective of the time delay from MI onset (Hochman et al., 2001). (Level of Evidence: B)

Class IIa

1. Urgent transfer to a PCI-capable hospital for coronary angiography is reasonable for patients with STEMI who demonstrate evidence of failed reperfusion or reocclusion after fibrinolytic therapy (Sutton et al., 2004; Gershlick et al., 2005; Wijeysundera et al., 2007; Collet et al., 2006). (Level of Evidence: B)
2. Transfer to a PCI-capable hospital for coronary angiography is reasonable for patients with STEMI who have received fibrinolytic therapy even when hemodynamically stable[§] and with clinical evidence of successful reperfusion. Angiography can be performed as soon as logistically feasible at the receiving hospital, and ideally within 24 hours, but should not be performed within the first 2 to 3 hours after administration of fibrinolytic therapy (Bøhmer et al., 2010; Borgia et al., 2010; Cantor et al., 2009; Di Mario et al., 2008; Fernandez-Avilés et al., 2004; White, 2008). (Level of Evidence: B)

[§]Although individual circumstances will vary, clinical stability is defined by the absence of low output, hypotension, persistent tachycardia, apparent shock, high-grade ventricular or symptomatic supraventricular tachyarrhythmias, and spontaneous recurrent ischemia.

Delayed Invasive Management

Coronary Angiography in Patients Who Initially Were Managed with Fibrinolytic Therapy or Who Did Not Receive Reperfusion

See Table 9 in the original guideline document for a summary of recommendations from this section.

Class I

1. Cardiac catheterization and coronary angiography with intent to perform revascularization should be performed after STEMI in patients with any of the following:
   a. Cardiogenic shock or acute severe HF that develops after initial presentation (Wu et al., 2002; Hochman et al., 2001; Steg et al., 2008; Steg et al., "Determinants and prognostic," 2004) (Level of Evidence: B)
   b. Intermediate- or high-risk findings on predischarge noninvasive ischemia testing (Erne et al., 2007; Madsen et al., 1997) (Level of Evidence: B)
   c. Myocardial ischemia that is spontaneous or provoked by minimal exertion during hospitalization. (Level of Evidence: C)

Class IIa

1. Coronary angiography with intent to perform revascularization is reasonable for patients with evidence of failed reperfusion or reocclusion after fibrinolytic therapy. Angiography can be performed as soon as logistically feasible (Sutton et al., 2004; Gershlick et al., 2005; Wijeysundera et al., 2007; Collet et al., 2006). (Level of Evidence: B)
2. Coronary angiography is reasonable before hospital discharge in stable[§] patients with STEMI after successful fibrinolytic therapy. Angiography can be performed as soon as logistically feasible, and ideally within 24 hours, but should not be performed within the first 2 to 3 hours after administration of fibrinolytic therapy (Bøhmer et al., 2010; Borgia et al., 2010; Cantor et al., 2009; Di Mario et al., 2008; Fernandez-Avilés et al., 2004; White, 2008; D'Souza et al., 2011). (Level of Evidence: B)

[§]Although individual circumstances will vary, clinical stability is defined by the absence of low output, hypotension, persistent tachycardia, apparent shock, high-grade ventricular or symptomatic supraventricular tachyarrhythmias, and spontaneous recurrent ischemia.

PCI of an Infarct Artery in Patients Who Initially Were Managed with Fibrinolysis or Who Did Not Receive Reperfusion Therapy

See Table 10 in the original guideline document for a summary of recommendations from this section.

Class I

1. PCI of an anatomically significant stenosis in the infarct artery should be performed in patients with suitable anatomy and any of the following:
   a. Cardiogenic shock or acute severe HF (Hochman et al., 2001) (Level of Evidence: B)
   b. Intermediate- or high-risk findings on predischarge noninvasive ischemia testing (Erne et al., 2007; Madsen et al., 1997) (Level of Evidence: C)
   c. Myocardial ischemia that is spontaneous or provoked by minimal exertion during hospitalization (Level of Evidence: C)

Class IIa

1. Delayed PCI is reasonable in patients with STEMI and evidence of failed reperfusion or reocclusion after fibrinolytic therapy. PCI can be performed as soon as logistically feasible at the receiving hospital (Gibson et al., 1999; Gibson et al., 2002; Sutton et al., 2004; Sutton et al., 2000) (Level of Evidence: B)

2. Delayed PCI of a significant stenosis in a patent infarct artery is reasonable in stable[§] patients with STEMI after fibrinolytic therapy. PCI can be performed as soon as logistically feasible at the receiving hospital, and ideally within 24 hours, but should not be performed within the first 2 to 3 hours after administration of fibrinolytic therapy (Bøhmer et al., 2010; Borgia et al., 2010; Cantor et al., 2009; Fernandez-Avilés et al., 2004; White, 2008). (Level of Evidence: B)

[§]Although individual circumstances will vary, clinical stability is defined by the absence of low output, hypotension, persistent tachycardia, apparent shock, high-grade ventricular or symptomatic supraventricular tachyarrhythmias, and spontaneous recurrent ischemia.

Class IIb

1. Delayed PCI of a significant stenosis in a patent infarct artery greater than 24 hours after STEMI may be considered as part of an invasive strategy in stable[§] patients (Hochman et al., "Coronary intervention," 2006; Erne et al., 2007; Madsen et al., 1997; Gibson et al., 2003; D'Souza et al., 2011; Gupta et al., 2003; Ioannidis & Katritsis, 2007; Steg et al., "DECOPI," 2004; Wilson et al., 2001). (Level of Evidence: B)

[§]Although individual circumstances will vary, clinical stability is defined by the absence of low output, hypotension, persistent tachycardia, apparent shock, high-grade ventricular or symptomatic supraventricular tachyarrhythmias, and spontaneous recurrent ischemia.

Class III: No Benefit

1. Delayed PCI of a totally occluded infarct artery greater than 24 hours after STEMI should not be performed in asymptomatic patients with 1- or 2-vessel disease if they are hemodynamically and electrically stable and do not have evidence of severe ischemia (Hochman et al., "Coronary intervention," 2006; Ioannidis & Katritsis, 2007). (Level of Evidence: B)

PCI of a Noninfarct Artery before Hospital Discharge

Class I

1. PCI is indicated in a noninfarct artery at a time separate from primary PCI in patients who have spontaneous symptoms of myocardial ischemia. (Level of Evidence: C)

Class IIa

1. PCI is reasonable in a noninfarct artery at a time separate from primary PCI in patients with intermediate- or high-risk findings on noninvasive testing (Hannan et al., 2010; Erne et al., 2007; Madsen et al., 1997). (Level of Evidence: B)

Adjunctive Antithrombotic Therapy to Support Delayed PCI after Fibrinolytic Therapy

See Table 11 in the original guideline document for a summary of recommendations from this section.

Antiplatelet Therapy to Support PCI After Fibrinolytic Therapy

Class I

1. After PCI, aspirin should be continued indefinitely (CURRENT-OASIS 7 Investigators, 2010; Antithrombotic Trialists' Collaboration, 2002; Smith et al., 2011; Mehta et al., 2010; Chen et al., "Addition of clopidogrel," 2005; Sabatine et al., 2005). (Level of Evidence: A)
2. Clopidogrel should be provided as follows:
   a. A 300-mg loading dose should be given before or at the time of PCI to patients who did not receive a previous loading dose and who are undergoing PCI within 24 hours of receiving fibrinolytic therapy (Level of Evidence: C)

b. A 600-mg loading dose should be given before or at the time of PCI to patients who did not receive a previous loading dose and who are undergoing PCI more than 24 hours after receiving fibrinolytic therapy (Level of Evidence: C)

c. A dose of 75 mg daily should be given after PCI (Wiviott et al., 2007; Montalescot et al., 2009; Chen et al., "Addition of clopidogrel," 2005; Sabatine et al., 2005) (Level of Evidence: C)

Class IIa

1. After PCI, it is reasonable to use 81 mg of aspirin per day in preference to higher maintenance doses (CURRENT-OASIS 7 Investigators, 2010; Mehta et al., 2010; Serebruany et al., 2005; Steinhubl et al., 2009). (Level of Evidence: B)

2. Prasugrel, in a 60-mg loading dose, is reasonable once the coronary anatomy is known in patients who did not receive a previous loading dose of clopidogrel at the time of administration of a fibrinolytic agent, but prasugrel should not be given sooner than 24 hours after administration of a fibrin-specific agent or 48 hours after administration of a non–fibrin-specific agent (Wiviott et al., 2007; Montalescot et al., 2009). (Level of Evidence: B)

3. Prasugrel, in a 10-mg daily maintenance dose, is reasonable after PCI (Wiviott et al., 2007; Montalescot et al., 2009). (Level of Evidence: B)

Class III: Harm

1. Prasugrel should not be administered to patients with a history of prior stroke or transient ischemic attack (Wiviott et al., 2007). (Level of Evidence: B)

Anticoagulant Therapy to Support PCI after Fibrinolytic Therapy

Class I

1. For patients with STEMI undergoing PCI after receiving fibrinolytic therapy with intravenous UFH, additional boluses of intravenous UFH should be administered as needed to support the procedure, taking into account whether GP IIb/IIIa receptor antagonists have been administered. (Level of Evidence: C)

2. For patients with STEMI undergoing PCI after receiving fibrinolytic therapy with enoxaparin, if the last subcutaneous dose was administered within the prior 8 hours, no additional enoxaparin should be given; if the last subcutaneous dose was administered between 8 and 12 hours earlier, enoxaparin 0.3 mg/kg IV should be given (Antman et al., 2002; Gibson et al., 2007). (Level of Evidence: B)

Class III: Harm

1. Fondaparinux should not be used as the sole anticoagulant to support PCI. An additional anticoagulant with anti-IIa activity should be administered because of the risk of catheter thrombosis (Yusuf et al., 2006). (Level of Evidence: C)

Coronary Artery Bypass Graft (CABG) Surgery

CABG in Patients with STEMI

Class I

1. Urgent CABG is indicated in patients with STEMI and coronary anatomy not amenable to PCI who have ongoing or recurrent ischemia, cardiogenic shock, severe HF, or other high-risk features (Caracciolo et al., 1995; Hochman et al., 2000; American College of Cardiology Foundation et al., 2011). (Level of Evidence: B)

2. CABG is recommended in patients with STEMI at time of operative repair of mechanical defects (Dalrymple-Hay et al., 1998; Menon et al., 2000; Slater et al., 2000; Tavakoli et al., 2002; Thompson et al., 2000). (Level of Evidence: B)

Class IIa

1. The use of mechanical circulatory support is reasonable in patients with STEMI who are hemodynamically unstable and require urgent CABG. (Level of Evidence: C)

Class IIb

1. Emergency CABG within 6 hours of symptom onset may be considered in patients with STEMI who do not have cardiogenic shock and are not candidates for PCI or fibrinolytic therapy. (Level of Evidence: C)

Timing of Urgent CABG in Patients with STEMI in Relation to Use of Antiplatelet Agents

Class I

1. Aspirin should not be withheld before urgent CABG (Jacob et al., 2011). (Level of Evidence: C)
2. Clopidogrel or ticagrelor should be discontinued at least 24 hours before urgent on-pump CABG, if possible (Kim et al., 2008; Held et al., 2011; Nijjer et al., 2011; Barker & Anderson, 2009; Ebrahimi et al., 2009). (Level of Evidence: B)
3. Short-acting intravenous GP IIb/IIIa receptor antagonists (eptifibatide, tirofiban) should be discontinued at least 2 to 4 hours before urgent CABG (Bizzarri et al., 2001; Dyke et al., 2000). (Level of Evidence: B)
4. Abciximab should be discontinued at least 12 hours before urgent CABG (Fernandez-Avilés et al., 2004). (Level of Evidence: B)

Class IIb

1. Urgent off-pump CABG within 24 hours of clopidogrel or ticagrelor administration might be considered, especially if the benefits of prompt revascularization outweigh the risks of bleeding (Held et al., 2011; Shim et al., 2007; Woo, Grand, & Valettas, 2003; Maltais, Perrault, & Do, 2008). (Level of Evidence: B)
2. Urgent CABG within 5 days of clopidogrel or ticagrelor administration or within 7 days of prasugrel administration might be considered, especially if the benefits of prompt revascularization outweigh the risks of bleeding. (Level of Evidence: C)

Routine Medical Therapies

Beta Blockers

Class I

1. Oral beta blockers should be initiated in the first 24 hours in patients with STEMI who do not have any of the following: signs of HF, evidence of a low-output state, increased risk for cardiogenic shock[¶], or other contraindications to use of oral beta blockers (PR interval more than 0.24 seconds, second- or third-degree heart block, active asthma, or reactive airways disease) (Chen et al., "Early intravenous," 2005; Roberts et al., 1991; "Randomised trial of intravenous atenolol," 1986). (Level of Evidence: B)
2. Beta blockers should be continued during and after hospitalization for all patients with STEMI and with no contraindications to their use ("A randomized trial of propranolol," 1982; Freemantle et al., 1999). (Level of Evidence: B)
3. Patients with initial contraindications to the use of beta blockers in the first 24 hours after STEMI should be reevaluated to determine their subsequent eligibility. (Level of Evidence: C)

[¶]Risk factors for cardiogenic shock (the greater the number of risk factors present, the higher the risk of developing cardiogenic shock) are age >70 years, systolic BP <120 mm Hg, sinus tachycardia >110 bpm or heart rate <60 bpm, and increased time since onset of symptoms of STEMI.

Class IIa

1. It is reasonable to administer intravenous beta blockers at the time of presentation to patients with STEMI and no contraindications to their use who are hypertensive or have ongoing ischemia (Chen et al., "Early intravenous," 2005; Roberts et al., 1991; "Randomised trial of intravenous atenolol," 1986). (Level of Evidence: B)

Renin-Angiotensin-Aldosterone System Inhibitors

Class I

1. An angiotensin-converting enzyme (ACE) inhibitor should be administered within the first 24 hours to all patients with STEMI with anterior location, HF, or ejection fraction (EF) less than or equal to 0.40, unless contraindicated (Pfeffer et al., 1992; Ball, Hall, & Murray, 1994; Køber et al., 1995; Pfeffer et al., 1997). (Level of Evidence: A)
2. An angiotensin receptor blocker (ARB) should be given to patients with STEMI who have indications for but are intolerant of ACE inhibitors (Pfeffer et al., 2003; Maggioni & Fabbri, 2005) (Level of Evidence: B)
3. An aldosterone antagonist should be given to patients with STEMI and no contraindications who are already receiving an ACE inhibitor and beta blocker and who have an EF less than or equal to 0.40 and either symptomatic HF or diabetes mellitus (Pitt et al., 2003). (Level of Evidence: B)

Class IIa

1. ACE inhibitors are reasonable for all patients with STEMI and no contraindications to their use ("Indications for ACE Inhibitors," 1998; "GISSI-3: effects of lisinopril," 1994; "ISIS-4: a randomised factorial trial," 1995). (Level of Evidence: A)

Lipid Management

Class I

1. High-intensity statin therapy should be initiated or continued in all patients with STEMI and no contraindications to its use (Cannon et al., 2006; Cholesterol Treatment Trialists' [CTT] Collaboration et al., 2010; Cannon et al., 2004). (Level of Evidence: B)

Class IIa

1. It is reasonable to obtain a fasting lipid profile in patients with STEMI, preferably within 24 hours of presentation. (Level of Evidence: C)

Complications after STEMI

Cardiogenic Shock

Treatment of Cardiogenic Shock

Class I

1. Emergency revascularization with either PCI or CABG is recommended in suitable patients with cardiogenic shock due to pump failure after STEMI irrespective of the time delay from MI onset (Hochman et al., 1999; Hochman et al., "Early revascularization," 2006; Babaev et al., 2005). (Level of Evidence: B)
2. In the absence of contraindications, fibrinolytic therapy should be administered to patients with STEMI and cardiogenic shock who are unsuitable candidates for either PCI or CABG (FTT Collaborative Group, 1994; Morrow et al., 2000; French et al., 2003). (Level of Evidence: B)

Class IIa

1. The use of intra-aortic balloon pump counterpulsation can be useful for patients with cardiogenic shock after STEMI who do not quickly stabilize with pharmacological therapy (Barron et al., 2001; Chen et al., 2003; Sanborn et al., 2000; Sjauw et al., 2009; Ohman et al., 2005). (Level of Evidence: B)

Class IIb

1. Alternative left ventricular (LV) assist devices for circulatory support may be considered in patients with refractory cardiogenic shock. (Level of Evidence: C)

Electrical Complications during the Hospital Phase of STEMI

Implantable Cardioverter-Defibrillator (ICD) Therapy before Discharge

Class I

1. ICD therapy is indicated before discharge in patients who develop sustained VT/VF more than 48 hours after STEMI, provided the arrhythmia is not due to transient or reversible ischemia, reinfarction, or metabolic abnormalities (Wever et al., 1995; Siebels & Kuck, 1994; Connolly et al., 2000). (Level of Evidence: B)

Bradycardia, Atrioventricular (AV) Block, and Intraventricular Conduction Defects

Pacing in STEMI

Class I

1. Temporary pacing is indicated for symptomatic bradyarrhythmias unresponsive to medical treatment. (Level of Evidence: C)

Pericarditis

Management of Pericarditis after STEMI

Class I

1. Aspirin is recommended for treatment of pericarditis after STEMI (Berman, Haffajee, & Alpert, 1981). (Level of Evidence: B)

Class IIb

1. Administration of acetaminophen, colchicine, or narcotic analgesics may be reasonable if aspirin, even in higher doses, is not effective. (Level of Evidence: C)

1. Glucocorticoids and nonsteroidal anti-inflammatory drugs are potentially harmful for treatment of pericarditis after STEMI (Bulkley & Roberts, 1974; Silverman & Pfeifer, 1987). (Level of Evidence: B)

Thromboembolic and Bleeding Complications

Thromboembolic Complications

<u>Anticoagulation</u>

Note: These recommendations apply to patients who receive intracoronary stents during PCI for STEMI. Among individuals with STEMI who do not receive an intracoronary stent, the duration of DAPT beyond 14 days has not been studied adequately for patients who undergo balloon angioplasty alone, are treated with fibrinolysis alone, or do not receive reperfusion therapy. In this subset of patients with STEMI who do not receive an intracoronary stent, the threshold for initiation of oral anticoagulation for secondary prevention, either alone or in combination with aspirin, may be lower, especially if a shorter duration (i.e., 14 days) of DAPT is planned (Andreotti et al., 2006).

<u>Class I</u>

1. Anticoagulant therapy with a vitamin K antagonist should be provided to patients with STEMI and atrial fibrillation with CHADS2 (Congestive heart failure, Hypertension, Age ≥75 years, Diabetes mellitus, previous Stroke/transient ischemic attack [doubled risk weight]) score greater than or equal to 2, mechanical heart valves, venous thromboembolism, or hypercoagulable disorder. (Level of Evidence: C)
2. The duration of triple antithrombotic therapy with a vitamin K antagonist, aspirin, and a $P2Y_{12}$ receptor inhibitor should be minimized to the extent possible to limit the risk of bleeding.** (Level of Evidence: C)

**Individual circumstances will vary and depend on the indications for triple therapy and the type of stent placed during PCI. After this initial treatment period, consider therapy with a vitamin K antagonist plus a single antiplatelet agent. For patients treated with fibrinolysis, consider triple therapy for 14 days, followed by a vitamin K antagonist plus a single antiplatelet agent (You et al., 2012; Vandvik et al., 2012; Lip et al., 2010; Faxon et al., 2011).

<u>Class IIa</u>

1. Anticoagulant therapy with a vitamin K antagonist is reasonable for patients with STEMI and asymptomatic LV mural thrombi. (Level of Evidence: C)

<u>Class IIb</u>

1. Anticoagulant therapy may be considered for patients with STEMI and anterior apical akinesis or dyskinesis. (Level of Evidence: C)
2. Targeting vitamin K antagonist therapy to a lower international normalized ratio (e.g., 2.0 to 2.5) might be considered in patients with STEMI who are receiving DAPT. (Level of Evidence: C)

<u>Risk Assessment after STEMI</u>

Use of Noninvasive Testing for Ischemia before Discharge

<u>Class I</u>

1. Noninvasive testing for ischemia should be performed before discharge to assess the presence and extent of inducible ischemia in patients with STEMI who have not had coronary angiography and do not have high-risk clinical features for which coronary angiography would be warranted (Théroux et al., 1979; Villlella et al., 1995; Leppo et al., 1984). (Level of Evidence: B)

<u>Class IIb</u>

1. Noninvasive testing for ischemia might be considered before discharge to evaluate the functional significance of a noninfarct artery stenosis previously identified at angiography. (Level of Evidence: C)
2. Noninvasive testing for ischemia might be considered before discharge to guide the postdischarge exercise prescription. (Level of Evidence: C)

Assessment of LV Function

<u>Class I</u>

1. LV ejection fraction (LVEF) should be measured in all patients with STEMI. (Level of Evidence: C)

Assessment of Risk for Sudden Cardiac Death

<u>Class I</u>

1. Patients with an initially reduced LVEF who are possible candidates for implantable cardioverter-defibrillator therapy should undergo reevaluation of LVEF 40 or more days after discharge (Epstein et al., 2008; Hohnloser et al., 2004; Steinbeck et al., 2009; Moss et al., 2002). (Level of Evidence: B)

<u>Post-hospitalization Plan of Care</u>

<u>Class I</u>

1. Posthospital systems of care designed to prevent hospital readmissions should be used to facilitate the transition to effective, coordinated outpatient care for all patients with STEMI (Naylor et al., 1994; Coleman et al., 2006; Young et al., 2003; Jack et al., 2009; Lappé et al., 2004). (Level of Evidence: B)
2. Exercise-based cardiac rehabilitation/secondary prevention programs are recommended for patients with STEMI (Leon et al., 2005; Suaya et al., 2009; Taylor et al., 2004; Goel et al., 2011). (Level of Evidence: B)
3. A clear, detailed, and evidence-based plan of care that promotes medication adherence, timely follow-up with the healthcare team, appropriate dietary and physical activities, and compliance with interventions for secondary prevention should be provided to patients with STEMI. (Level of Evidence: C)
4. Encouragement and advice to stop smoking and to avoid second-hand smoke should be provided to patients with STEMI (Wilson et al., 2000; Thomson & Rigotti, 2003; Dawood et al., 2008; Shah et al., 2010). (Level of Evidence: A)

<u>Definitions:</u>

Applying Classification of Recommendations and Level of Evidence

		Size of Treatment Effect					
		CLASS I *Benefit >>> Risk* Procedure/Treatment SHOULD be performed/ administered	CLASS IIa *Benefit >> Risk* *Additional studies with focused objectives needed* IT IS REASONABLE to perform procedure/administer treatment	CLASS IIb *Benefit ≥ Risk* *Additional studies with broad objectives needed; additional registry data would be helpful* Procedure/Treatment MAY BE CONSIDERED	CLASS III *No Benefit* or Class III *Harm*		
						Procedure/Test	**Treatment**
					COR III: No Benefit	Not helpful	No proven benefit
					COR III: Harm	Excess Cost without Benefit or Harmful	Harmful to Patients
Estimate of Certainty (Precision) of Treatment Effect	LEVEL A Multiple populations evaluated* Data derived from multiple randomized clinical trials or meta-analyses	• Recommendation that procedure or treatment is useful/effective • Sufficient evidence from multiple randomized trials or meta-analyses	• Recommendation in favor of treatment or procedure being useful/effective • Some conflicting evidence from multiple randomized trials or meta-analyses	• Recommendation's usefulness/efficacy less well established • Greater conflicting evidence from multiple randomized trials or meta-analyses	• Recommendation that procedure or treatment is not useful/effective and may be harmful • Sufficient evidence from multiple randomized trials or meta-analyses		
	LEVEL B Limited populations evaluated* Data derived from a single randomized clinical trials or nonrandomized studies	• Recommendation that procedure or treatment is useful/effective • Evidence from single randomized trial or nonrandomized studies	• Recommendation in favor of treatment or procedure being useful/effective • Some conflicting evidence from single randomized trial or nonrandomized studies	• Recommendation's usefulness/efficacy less well established • Greater conflicting evidence from single randomized trial or nonrandomized studies	• Recommendation that procedure or treatment is not useful/effective and may be harmful • Evidence from single randomized trial or nonrandomized studies		
	LEVEL C Very limited populations evaluated* Only consensus opinion of experts, case studies or standard of care	• Recommendation that procedure or treatment is useful/effective • Only expert opinion, case studies, or standard of care	• Recommendation in favor of treatment or procedure being useful/effective • Only diverging expert opinion, case studies, or standard of care	• Recommendation's usefulness/efficacy less well established • Only diverging expert opinion, case studies, or standard of care	• Recommendation that procedure or treatment is not useful/effective and may be harmful • Only expert opinion, case studies, or standard of care		

A recommendation with Level of Evidence B or C does not imply that the recommendation is weak. Many important clinical questions addressed in the guidelines do not lend themselves to clinical trials. Although randomized trials are unavailable, there may be a very clear clinical consensus that a particular test or therapy is useful or effective.

*Data available from clinical trials or registries about the usefulness/efficacy in different subpopulations, such as gender, age, history of diabetes, history of prior myocardial infarction, history of heart failure, and prior aspirin use.

Clinical Algorithm(s)

A clinical algorithm for reperfusion therapy for patients with ST-elevation myocardial infarction (STEMI) is provided in the original guideline document.

Scope

Disease/Condition(s)

ST-elevation myocardial infarction (STEMI)

Guideline Category

Diagnosis

Evaluation

Management

Risk Assessment

Treatment

Clinical Specialty

Cardiology

Critical Care

Emergency Medicine

Family Practice

Internal Medicine

Radiology

Thoracic Surgery

Intended Users

Advanced Practice Nurses

Emergency Medical Technicians/Paramedics

Health Care Providers

Nurses

Pharmacists

Physician Assistants

Physicians

Guideline Objective(s)

- To review the management of patients with ST-elevation myocardial infarction (STEMI), with particular emphasis on advances in reperfusion therapy, organization of regional systems of care, transfer algorithms, evidence-based antithrombotic and medical therapies, and secondary prevention strategies to optimize patient-centered care
- To assist healthcare providers in clinical decision making by describing a range of generally acceptable approaches for the diagnosis, management, and prevention of STEMI

Target Population

- Adults with ST-elevation myocardial infarction (STEMI)
- Adults at risk of STEMI

Interventions and Practices Considered

Diagnosis/Evaluation/Risk Assessment

1. Performance of a 12-lead electrocardiogram (ECG) by emergency medical services (EMS) personnel at the site of first medical contact (FMC)
2. Evaluation of patients with ST-elevation myocardial infarction (STEMI) and out-of-hospital cardiac arrest (immediate angiography)
3. Risk assessment after STEMI
   - Noninvasive testing for ischemia in patients who have not undergone angiography or who have a significant stenosis in a noninfarct artery
   - Assessment of left ventricular function
   - Assessment of risk for sudden cardiac death

Management/Treatment

1. Creating and maintaining a regional system of STEMI care
2. Administration of reperfusion therapy to all eligible patients (preferably within 12 hours of symptom onset)
3. Primary percutaneous coronary intervention (PCI) as method of reperfusion
4. EMS—rather than private—transport to PCI-capable facility
5. Management of patients with STEMI and out-of-hospital cardiac arrest (use of therapeutic hypothermia and PCI as indicated)
6. Manual aspiration thrombectomy
7. Placement of a stent (bare-metal stent or drug-eluting stent)
8. Antiplatelet therapy to support primary PCI (aspirin, $P2Y_{12}$ receptor inhibitor, glycoprotein [GP] IIb/IIIa receptor antagonist)
9. Anticoagulant therapy to support primary PCI (unfractionated heparin, bivalirudin, fondaparinux) (fondaparinux not recommended as sole anticoagulant)
10. Fibrinolytic therapy if anticipated delay to performing primary PCI exceeds 120 minutes from time of first medical contact
11. Adjunctive antiplatelet or anticoagulant therapy after fibrinolytic therapy
12. Immediate transfer to a PCI-capable hospital for coronary angiography (CA) after fibrinolytic therapy whether successful or unsuccessful
13. PCI of an infarct artery with a significant stenosis in patients who initially were managed with fibrinolysis or who did not receive reperfusion therapy
14. PCI of a significant stenosis in a noninfarct artery at a time removed from primary PCI and before hospital discharge in patients without cardiogenic shock or severe heart failure
15. PCI of a noninfarct artery at time of primary PCI for patients with cardiogenic shock or severe heart failure
16. Urgent coronary artery bypass graft (CABG) when indicated
17. Timing of urgent CABG in relation to use of antiplatelet agents
18. Routine medical therapies
    - Beta-blockers
    - Angiotensin-converting enzyme (ACE) inhibitors
    - Angiotensin receptor blockers
    - Aldosterone antagonists
    - Lipid management, including statin therapy and fasting lipid profile

19. Management of complications after STEMI
    - Treatment of cardiogenic shock (emergency revascularization with either PCI or CA, alternative left ventricular [LV] assist devices)
    - Electrical complications (implantable cardioverter-defibrillator therapy, temporary pacing)
    - Management of pericarditis (aspirin and analgesics)
    - Thromboembolic and bleeding complications (anticoagulant therapy with a vitamin K antagonist)
20. Posthospital systems of care designed to prevent hospital readmissions, including detailed plans of care
21. Exercise-based cardiac rehabilitation/secondary prevention programs
22. Encouragement and advice to stop smoking and avoidance of second-hand smoke

Note: Glucocorticoids and nonsteroidal anti-inflammatory drugs not recommended for management of pericarditis.

Major Outcomes Considered

- Morbidity and mortality due to ST-elevation myocardial infarction (STEMI)
- Primary prevention of STEMI
- Secondary prevention of cardiovascular events, including second myocardial infarction, sudden cardiac death, recurrent myocardial ischemia, stroke
- Time to treatment
- Incidence of serious bleeding or stroke
- Rates of adverse events and/or side effects of treatment options

Methodology

Methods Used to Collect/Select the Evidence

Hand-searches of Published Literature (Primary Sources)

Hand-searches of Published Literature (Secondary Sources)

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

The recommendations listed in this document are, whenever possible, evidence based. The current document constitutes a full revision and includes an extensive evidence review, which was conducted through November 2010, with additional selected references added through August 2012. PubMed and the Cochrane Collaboration Database were used. Searches were limited to studies conducted in human subjects and reviews and other evidence pertaining to human subjects; all were published in English. Key search words included but were not limited to: *acute coronary syndromes, percutaneous coronary intervention, coronary artery bypass graft, myocardial infarction, ST-elevation myocardial infarction, coronary stent, revascularization, anticoagulant therapy, antiplatelet therapy, antithrombotic therapy, glycoprotein IIb/IIIa inhibitor therapy, pharmacotherapy, proton-pump inhibitor, implantable cardioverter-defibrillator therapy, cardiogenic shock, fibrinolytic therapy, thrombolytic therapy, nitrates, mechanical complications, arrhythmia, angina, chronic stable angina, diabetes, chronic kidney disease, mortality, morbidity, elderly, ethics,* and *contrast nephropathy.* Additional searches cross-referenced these topics with the following subtopics: *percutaneous coronary intervention, coronary artery bypass graft, cardiac rehabilitation,* and *secondary prevention.* Additionally, the committee reviewed documents related to the subject matter previously published by the American College of Cardiology Foundation (ACCF) and American Heart Association (AHA). References selected and published in this document are representative and not all-inclusive.

Number of Source Documents

Not stated

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Applying Classification of Recommendations and Level of Evidence

		Size of Treatment Effect					
		CLASS I *Benefit >>> Risk* Procedure/Treatment SHOULD be performed/administered	**CLASS IIa** *Benefit >> Risk* *Additional studies with focused objectives needed* IT IS REASONABLE to perform procedure/administer treatment	**CLASS IIb** *Benefit ≥ Risk* *Additional studies with broad objectives needed; additional registry data would be helpful* Procedure/Treatment MAY BE CONSIDERED	**CLASS III** *No Benefit* or Class III *Harm*		
						Procedure/Test	**Treatment**
					COR III: No Benefit	Not helpful	No proven benefit
					COR III: Harm	Excess Cost without Benefit or Harmful	Harmful to Patients
Estimate of Certainty (Precision) of Treatment Effect	**LEVEL A** Multiple populations evaluated* Data derived from multiple randomized clinical trials or meta-analyses	• Recommendation that procedure or treatment is useful/effective • Sufficient evidence from multiple randomized trials or meta-analyses	• Recommendation in favor of treatment or procedure being useful/effective • Some conflicting evidence from multiple randomized trials or meta-analyses	• Recommendation's usefulness/efficacy less well established • Greater conflicting evidence from multiple randomized trials or meta-analyses	• Recommendation that procedure or treatment is not useful/effective and may be harmful • Sufficient evidence from multiple randomized trials or meta-analyses		
	LEVEL B Limited populations evaluated* Data derived from a single randomized clinical trials or nonrandomized studies	• Recommendation that procedure or treatment is useful/effective • Evidence from single randomized trial or nonrandomized studies	• Recommendation in favor of treatment or procedure being useful/effective • Some conflicting evidence from single randomized trial or nonrandomized studies	• Recommendation's usefulness/efficacy less well established • Greater conflicting evidence from single randomized trial or nonrandomized studies	• Recommendation that procedure or treatment is not useful/effective and may be harmful • Evidence from single randomized trial or nonrandomized studies		
	LEVEL C Very limited populations evaluated* Only consensus opinion of experts, case studies or standard of care	• Recommendation that procedure or treatment is useful/effective • Only expert opinion, case studies, or standard of care	• Recommendation in favor of treatment or procedure being useful/effective • Only diverging expert opinion, case studies, or standard of care	• Recommendation's usefulness/efficacy less well established • Only diverging expert opinion, case studies, or standard of care	• Recommendation that procedure or treatment is not useful/effective and may be harmful • Only expert opinion, case studies, or standard of care		

A recommendation with Level of Evidence B or C does not imply that the recommendation is weak. Many important clinical questions addressed in the guidelines do not lend themselves to clinical trials. Although randomized trials are unavailable, there may be a very clear clinical consensus that a particular test or therapy is useful or effective.

*Data available from clinical trials or registries about the usefulness/efficacy in different subpopulations, such as gender, age, history of diabetes, history of prior myocardial infarction, history of heart failure, and prior aspirin use.

Methods Used to Analyze the Evidence

Review of Published Meta-Analyses

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

To provide clinicians with a comprehensive set of data, whenever deemed appropriate or when published, the absolute risk difference and number needed to treat or harm are provided in the guideline, along with confidence intervals (CI) and data related to the relative treatment effects such as odds ratio (OR), relative risk (RR), hazard ratio (HR), or incidence rate ratio

Methods Used to Formulate the Recommendations

Expert Consensus

Description of Methods Used to Formulate the Recommendations

Experts in the subject under consideration are selected by the American College of Cardiology Foundation (ACCF) and American Heart Association (AHA) to examine subject-specific data and write guidelines in partnership with representatives from other medical organizations and specialty groups. Writing committees are asked to perform a formal literature review; weigh the strength of evidence for or against particular tests, treatments, or procedures; and include estimates of expected outcomes where such data exist. Patient-specific modifiers, comorbidities, and issues of patient preference that may influence the choice of tests or therapies are considered. When available, information from studies on cost is considered, but data on efficacy and outcomes constitute the primary basis for the recommendations contained herein.

In analyzing the data and developing recommendations and supporting text, the writing committee uses evidence-based methodologies developed by the Task Force. The Class of Recommendation (COR) is an estimate of the size of the treatment effect considering risks versus benefits in addition to evidence and/or agreement that a given treatment or procedure is or is not useful/effective or in some situations may cause harm. The Level of Evidence (LOE) is an estimate of the certainty or precision of the treatment effect. The writing committee reviews and ranks evidence supporting each recommendation with the weight of evidence ranked as LOE A, B, or C according to specific definitions that are included in the "Rating Scheme for the Strength of the Evidence" field. Studies are identified as observational, retrospective, prospective, or randomized where appropriate. For certain conditions for which inadequate data are available, recommendations are based on expert consensus and clinical experience and are ranked as LOE C. When recommendations at LOE C are supported by historical clinical data, appropriate references (including clinical reviews) are cited if available. For issues for which sparse data are available, a survey of current practice among the members of the writing committee is the basis for LOE C recommendations and no references are cited.

A new addition to this methodology is separation of the Class III recommendations to delineate whether the recommendation is determined to be of "no benefit" or is associated with "harm" to the patient. In addition, in view of the increasing number of comparative effectiveness studies, comparator verbs and suggested phrases for writing recommendations for the comparative effectiveness of one treatment or strategy versus another are included for COR I and IIa, LOE A or B only.

The writing committee was composed of experts representing cardiovascular medicine, interventional cardiology, electrophysiology, heart failure (HF), cardiac surgery, emergency medicine, internal medicine, cardiac rehabilitation, nursing, and pharmacy. The American College of Physicians, American College of Emergency Physicians, and Society for Cardiovascular Angiography and Interventions assigned official representatives.

Rating Scheme for the Strength of the Recommendations

See the "Rating Scheme for the Strength of the Evidence" field, above.

Cost Analysis

The guideline developers reviewed published cost analyses.

Method of Guideline Validation

External Peer Review

Internal Peer Review

Description of Method of Guideline Validation

This document was reviewed by 2 outside reviewers each nominated by the American College of Cardiology Foundation (ACCF) and the American Heart Association (AHA), as well as 2 reviewers each from the American College of Emergency Physicians (ACEP) and Society for Cardiovascular Angiography and Interventions (SCAI) and 22 individual content reviewers (including members from the ACCF Interventional Scientific Council and ACCF Surgeons' Scientific Council). All reviewer relationship with industry (RWI) information was distributed to the writing committee and is published in the original guideline Appendix.

This document was approved for publication by the governing bodies of the ACCF and the AHA and was endorsed by the ACEP and SCAI.

Evidence Supporting the Recommendations

References Supporting the Recommendations

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Type of Evidence Supporting the Recommendations

The type of supporting evidence is identified and graded for each recommendation (see the "Major Recommendations" field).

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

- Decreased morbidity and mortality due to ST-elevation myocardial infarction (STEMI)
- Effective secondary prevention of myocardial infarction and other cardiovascular events

Potential Harms

- Potential complications of primary percutaneous coronary intervention (PCI) include problems with the arterial access site; adverse reactions to volume loading, contrast medium, and antithrombotic medications; technical complications; and reperfusion events.
- Nonfatal and fatal bleeding can occur in patients treated with fibrinolytic therapy, aspirin, clopidogrel, and/or vitamin K antagonists.
- Although "false positives" are a concern when emergency medical services (EMS) personnel and/or emergency physicians are allowed to activate the cardiac catheterization laboratory, the rate of false activations is relatively low (approximately 15%) and is more than balanced by earlier treatment times for the majority of patients for whom notification is appropriate.
- Until further data become available, it would seem prudent to weigh the possible increased risk of intracranial bleeding when the addition of ticagrelor to aspirin is considered in patients with prior stroke or transient ischemic attack.
- Glycoprotein IIb/IIIa inhibitors should be used with great caution, if at all, after full-dose fibrinolytic therapy, because this combination is associated with high rates of bleeding and intracranial hemorrhage (ICH), particularly in the elderly.
- Although pericarditis is not an absolute contraindication to anticoagulation, caution should be exercised because of the potential for hemorrhagic conversion.
- Caution is advised when using calcium channel blockers in patients with left ventricular systolic dysfunction.
- Heparin-induced thrombocytopenia (HIT), with and without thrombotic complications, can infrequently complicate the course of patients with acute coronary syndrome (ACS), particularly patients who previously have been exposed to heparin or who receive heparin over several hospital days. From 1% to 5% of all patients receiving heparin will develop HIT, and of these, 25% to 50% will develop thrombotic complications.

See Table 12 in the original guideline document for risks of selected medical therapies.

Contraindications

Contraindications

- Fondaparinux should not be given as the sole anticoagulant to patients referred for percutaneous coronary intervention (PCI) and is contraindicated for patients with a creatinine clearance less than 30 mL/min.
- Drug-eluting stents (DES) should not be used in primary PCI for patients with ST-elevation myocardial infarction (STEMI) who are unable to tolerate or comply with a prolonged course of dual antiplatelet therapy (DAPT) because of the increased risk of stent thrombosis with premature discontinuation of one or both agents.
- Avoid eptifibatide in patients on hemodialysis.
- Oral beta-blockers are contraindicated in patients with signs of heart failure (HF), evidence of a low output state, increased risk for cardiogenic shock.
- Refer to Table 12 in the original guideline document for contraindications/cautions of routine medical therapy used in STEMI.

Contraindications and Cautions for Fibrinolytic Therapy in STEMI*

Absolute Contraindications

- Any prior intracranial hemorrhage
- Known structural cerebral vascular lesion (e.g., arteriovenous malformation)
- Known malignant intracranial neoplasm (primary or metastatic)
- Ischemic stroke within 3 months (EXCEPT acute ischemic stroke within 4.5 h)
- Suspected aortic dissection
- Active bleeding or bleeding diathesis (excluding menses)
- Significant closed-head or facial trauma within 3 months
- Intracranial or intraspinal surgery within 2 months
- Severe uncontrolled hypertension (unresponsive to emergency therapy)
- For streptokinase, prior treatment within the previous 6 months

Relative Contraindications

- History of chronic, severe, poorly controlled hypertension
- Significant hypertension on presentation (systolic blood pressure >180 mm Hg or diastolic blood pressure >110 mm Hg)

- History of prior ischemic stroke >3 months
- Dementia
- Known intracranial pathology not covered in absolute contraindications
- Traumatic or prolonged (>10 min) cardiopulmonary resuscitation (CPR)
- Major surgery (<3 weeks)
- Recent (within 2 to 4 weeks) internal bleeding
- Noncompressible vascular punctures
- Pregnancy
- Active peptic ulcer
- Oral anticoagulant therapy

*Viewed as advisory for clinical decision making and may not be all-inclusive or definitive.

Qualifying Statements

Qualifying Statements

- Because the American College of Cardiology Foundation (ACCF) and the American Heart Association (AHA) practice guidelines address patient populations (and healthcare providers) residing in North America, drugs that are not currently available in North America are discussed in the text without a specific class of recommendation (COR). For studies performed in large numbers of subjects outside North America, each writing committee reviews the potential influence of different practice patterns and patient populations on the treatment effect and relevance to the ACCF/AHA target population to determine whether the findings should inform a specific recommendation.
- The ACCF/AHA practice guidelines are intended to assist healthcare providers in clinical decision making by describing a range of generally acceptable approaches to the diagnosis, management, and prevention of specific diseases or conditions. The guidelines attempt to define practices that meet the needs of most patients in most circumstances. The ultimate judgment regarding care of a particular patient must be made by the healthcare provider and patient in light of all the circumstances presented by that patient. As a result, situations may arise for which deviations from these guidelines may be appropriate. Clinical decision making should involve consideration of the quality and availability of expertise in the area where care is provided. When these guidelines are used as the basis for regulatory or payer decisions, the goal should be improvement in quality of care. The Task Force recognizes that situations arise in which additional data are needed to inform patient care more effectively; these areas are identified within each respective guideline when appropriate.
- Prescribed courses of treatment in accordance with these recommendations are effective only if followed. Because lack of patient understanding and adherence may adversely affect outcomes, physicians and other healthcare providers should make every effort to engage the patient's active participation in prescribed medical regimens and lifestyles. In addition, patients should be informed of the risks, benefits, and alternatives to a particular treatment and should be involved in shared decision making whenever feasible, particularly for COR IIa and IIb, for which the benefit-to-risk ratio may be lower.

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Implementation Tools

Clinical Algorithm

Quick Reference Guides/Physician Guides

Slide Presentation

For information about availability, see the *Availability of Companion Documents* and *Patient Resources* fields below.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Getting Better

Living with Illness

IOM Domain

Effectiveness

Patient-centeredness

Timeliness

Identifying Information and Availability

Bibliographic Source(s)

O'Gara PT, Kushner FG, Ascheim DD, Casey DE Jr, Chung MK, de Lemos JA, Ettinger SM, Fang JC, Fesmire FM, Franklin BA, Granger CB, Krumholz HM, Linderbaum JA, Morrow DA, Newby LK, Ornato JP, Ou N, Radford MJ, Tamis-Holland JE, Tommaso CL, Tracy CM, Woo YJ, Zhao DX. 2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol. 2013 Jan 29;61(4):e78-140. [656 references] PubMed

Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

1996 Nov 1 (revised 2013 Jan 29)

Guideline Developer(s)

American College of Cardiology Foundation - Medical Specialty Society

American Heart Association - Professional Association

Source(s) of Funding

The American College of Cardiology Foundation and the American Heart Association

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American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines

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Financial Disclosures/Conflicts of Interest

The Task Force makes every effort to avoid actual, potential, or perceived conflicts of interest that may arise as a result of relationships with industry and other entities (RWI) among the members of the writing committee. All writing committee members and peer reviewers of the guideline are required to disclose all current healthcare related relationships, including those existing 12 months before initiation of the writing effort. In December 2009, the American College of Cardiology Foundation (ACCF) and American Heart Association (AHA) implemented a new RWI policy that requires the writing committee chair plus a minimum of 50% of the writing committee to have no *relevant* RWI (Appendix 1 in the original guideline document includes the ACCF/AHA definition of *relevance*). These statements are reviewed by the Task Force and all members during each conference call and/or meeting of the writing committee, and members provide updates as changes occur. All guideline recommendations require a confidential vote by the writing committee and must be approved by a consensus of the voting members. Members may not draft or vote on any text or recommendations pertaining to their RWI. Members who recused themselves from voting are indicated in the list of writing committee members, and specific section recusals are noted in Appendix 1 in the original guideline document. Authors' and peer reviewers' RWI pertinent to this guideline are disclosed in Appendixes 1 and 2, respectively in the original guideline document. In addition, to ensure complete transparency, writing committee members' comprehensive disclosure information—including RWI not pertinent to this document—is available as an online supplement. Comprehensive disclosure information for the Task Force is also available from the American College of Cardiology Web site [   ]. The work of the writing committees is supported exclusively by the ACCF and AHA without commercial support. Writing committee members volunteered their time for this activity.

Guideline Endorser(s)

American College of Emergency Physicians - Medical Specialty Society

Society for Cardiovascular Angiography and Interventions - Medical Specialty Society

Guideline Status

This is the current release of the guideline.

This guideline updates previous versions: Antman EM, Anbe DT, Armstrong PW, Bates ER, Green LA, Hand M, Hochman JS, Krumholz HM, Kushner FG, Lamas GA, Mullany CJ, Ornato JP, Pearle DL, Sloan MA, Smith SC Jr. ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction. A report of the Am Coll of Cardiol/Am Heart Assoc Task Force on Practice Guidelines (Committee to revise the 1999 guidelines). Bethesda (MD): American College of Cardiology (ACC), American Heart Association (AHA); 2004. 211 p.

Canadian Cardiovascular Society, American Academy of Family Physicians, American College of Cardiology, American Heart Association, Antman EM, Hand M, Armstrong PW, Bates ER, Green LA, Halasyamani LK, Hochman JS, Krumholz HM, Lamas GA, Mullany CJ, Pearle

DL, Sloan MA, Smith SC Jr, Anbe DT, Kushner FG, Ornato JP, Pearle DL, Sloan MA, Jacobs AK, Adams CD, Anderson JL, Buller CE, Creager MA, Ettinger SM, Halperin JL, Hunt SA, Lytle BW, Nishimura R, Page RL, Riegel B, Tarkington LG, Yancy CW. 2007 focused update of the ACC/AHA 2004 guidelines for the management of patients with ST-elevation myocardial infarction: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol 2008 Jan 15;51(2):210-47.

Guideline Availability

Electronic copies: Available from the Journal of the American College of Cardiology Web site   and from the Circulation Web site   .

Print copies: Available from the American College of Cardiology, 2400 N Street NW, Washington DC, 20037; (800) 253-4636 (US only).

Availability of Companion Documents

The following are available:

- O'Gara PT, Kushner FG, Ascheim DD, Casey DE Jr, Chung MK, de Lemos JA, Ettinger SM, Fang JC, Fesmire FM, Franklin BA, Granger CB, Krumholz HM, Linderbaum JA, Morrow DA, Newby LK, Ornato JP, Ou N, Radford MJ, Tamis-Holland JE, Tommaso CL, Tracy CM, Woo YJ, Zhao DX. 2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction: executive summary. A report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol 2013;61(4):485-510. Electronic copies: Available in Portable Document Format (PDF) from the Journal of the American College of Cardiology (JACC) Web site   .
- 2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction. A report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. Slide set. 2013. 126 p. Electronic copies: Available from the JACC Web site   .
- 2013 STEMI guideline data supplements. 2013. 17 p. Electronic copies: Available in PDF from the JACC Web site   .
- Top ten things to know about the management of ST-elevation myocardial infarction. 2013. 1 p. Electronic copies: Available in PDF from the American Heart Association (AHA) Web site   .
- Methodology manual and policies from the ACCF/AHA Task Force on Practice Guidelines. 2010 Jun. 88 p. Electronic copies: Available in Portable Document Format (PDF) from the AHA Web site   .

Patient Resources

None available

NGC Status

The original NGC summary was completed by ECRI on June 30, 1998. The summary was updated by ECRI on September 2, 1999. This updated information was verified by the guideline developer on October 8, 1999. This summary was updated most recently on September 10, 2004. The updated information was verified by the guideline developer on February 23, 2005. This summary was updated on May 3, 2005 following the withdrawal of Bextra (valdecoxib) from the market and the release of heightened warnings for Celebrex (celecoxib) and other nonselective nonsteroidal anti-inflammatory drugs (NSAIDs). This summary was updated by ECRI on June 16, 2005, following the U.S. Food and Drug Administration advisory on COX-2 selective and non-selective non-steroidal anti-inflammatory drugs (NSAIDs). This summary was updated by ECRI on March 6, 2007 following the FDA advisory on Coumadin (warfarin sodium). This summary was updated by ECRI Institute on June 22, 2007 following the U.S. Food and Drug Administration (FDA) advisory on heparin sodium injection. This summary was updated by ECRI Institute on September 7, 2007 following the revised U.S. Food and Drug Administration (FDA) advisory on Coumadin (warfarin). This summary was updated by ECRI Institute on November 6, 2007, following the U.S. Food and Drug Administration advisory on Antidepressant drugs. This NGC summary was updated most recently by ECRI Institute on March 25, 2008. The updated information was verified by the guideline developer on August 4, 2008. This summary was updated by ECRI Institute on December 26, 2008 following the FDA advisory on Innohep (tinzaparin). This summary was updated by ECRI Institute on July 20, 2009 following the U.S. Food and Drug Administration advisory on Varenicline and Bupropion. This summary was updated by ECRI Institute on August 14, 2009 following the updated Colchicine advisory. This

summary was updated by ECRI Institute on January 5, 2010 following the U.S. Food and Drug Administration advisory on Plavix (Clopidogrel). This summary was updated by ECRI Institute on May 17, 2010 following the U.S. Food and Drug Administration advisory on Plavix (clopidogrel). This summary was updated by ECRI Institute on July 26, 2010 following the U.S. Food and Drug Administration (FDA) advisory on Proton Pump Inhibitors (PPI). This summary was updated by ECRI Institute on July 27, 2010 following the FDA drug safety communication on Heparin. This summary was updated by ECRI Institute on June 27, 2011 following the U.S. Food and Drug Administration advisory on Zocor (simvastatin). This summary was updated by ECRI Institute on April 13, 2012 following the U.S. Food and Drug Administration advisories on Statin Drugs and Statins and HIV or Hepatitis C drugs. This summary was updated by ECRI Institute on March 27, 2013. The updated information was verified by the guideline developer on May 7, 2013. This summary was updated by ECRI Institute on October 28, 2013 following the U.S. Food and Drug Administration advisory on Acetaminophen. This summary was updated by ECRI Institute on March 10, 2014 following the U.S. Food and Drug Administration advisory on Low Molecular Weight Heparins.

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